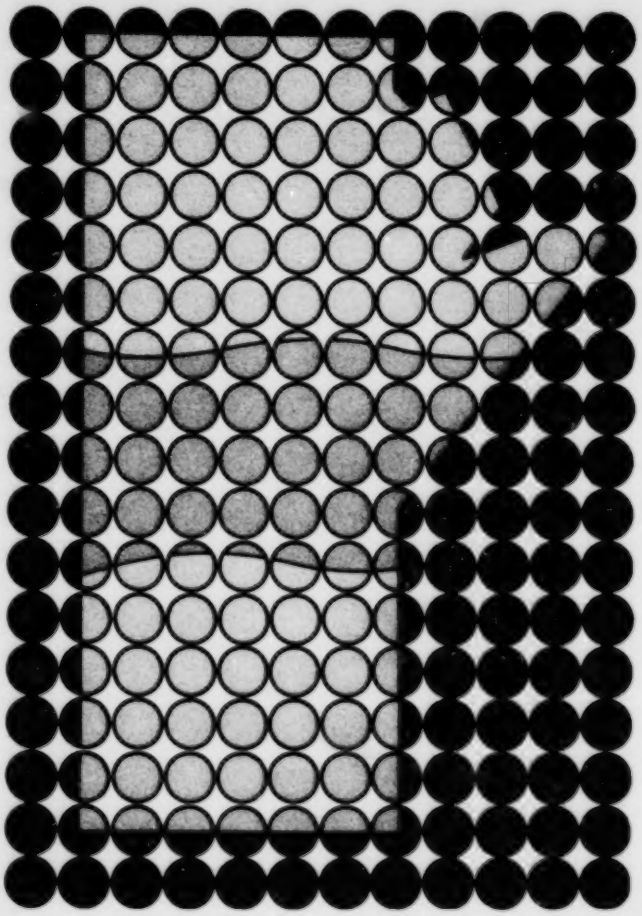

CANADA — MANITOBA
Soil Survey

Soils of the Whitemouth Peatland

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SOILS OF THE WHITEMOUTH PEATLAND

by

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CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA

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DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

PREFACE

This report and map of the detailed field and laboratory study of the soils of the Whitemouth peatland is one in an ongoing series of such soil survey reports covering special interest areas in southern Manitoba. These reports are in response to a growing awareness by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the development and distribution of the soils of Manitoba is the key to understanding their properties, behaviour and response to management. This awareness requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, in the rural community of Whitemouth, development for agriculture, recreation and related uses requires delineation of land of high or low suitability for such uses which in turn depends on an accurate and reliable soil map as a basic reference document.

The land resource information included in this resurvey covers approximately 9 330 hectares of land in the Whitemouth peatland. The projected intensive use of the soils of this area has created a need for more up-to-date, more accurate and more detailed soil information. Increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory, and the accumulated knowledge of the properties and uses of soils over the years, have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey, a large volume of site specific data for the soils mapped in the Whitemouth peatland was generated that, for practical reasons, cannot be included in this report. These data are archived in the Canada Soil Information System (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data are available on request. In addition, the Cartographic File of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps such as drainage, texture of surface deposits, slope, and stoniness. A package of interpretive maps and single feature derivative maps can be made available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba, Winnipeg Manitoba, R3T 2N2.

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

ACKNOWLEDGEMENTS

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PART 1

GENERAL DESCRIPTION OF THE WHITEMOUTH PEATLAND

1.1 LOCATION

The Whitemouth peatland lies in eastern Manitoba in the Rural Municipality of Whitemouth (Figure 1). The area mapped is roughly 9 330 hectares or one township . Majority of the peatland falls within township 12 and 13 range 12, with a few hectares falling in townships 12 and 13 range 11.

1.2 RELIEF AND DRAINAGE

One river (Bog River) flows in the south end of the Whitemouth peatland and is lost in the central portion of the bog and reappears flowing out the north west corner of the peatland. Besides the Bog River, Smith and Oldenberg Creeks provide drainage for the peatland. These waterways flow into the Whitemouth river, which then empties into the Winnipeg River. A number of ditches emptying into the Whitemouth River drain this area also. The peatland is located between a bedrock high controlled area to the east and a mineral soil high on the west side. The slope is 1.5 meters per mile, dropping to the west as shown by contours in Figure 2. The peatland also slopes northward toward Natalie and Eleanor Lakes at 0.6 meters per mile. All the investigation sites are shown on Figure 2, with the depth of the organic deposit being the bottom number. Water chemistry for some of these sites is given in Appendix E.

1.3 CLIMATE

In relation to world wide climatic conditions, the Whitemouth study area lies within the region designated by Koppen as Dfb, a region located in the center of a continent at a great distance from the moderating affect of oceans. In the Whitemouth area summer temperatures are higher, winter temperatures are lower and the annual temperature range is much greater than the world average where Dfb climate occur.

In the study area mean annual air temperatures range from approximately 1.5°C in the Pinawa area to 2.1°C in the Seven Sister Falls area. Annual average precipitation ranges from 345 mm at Seven Sisters Falls to 347 mm at Pinawa. Frost free period, when temperature exceed 0°C, ranges from 110 days at Pinawa to 119 days at Seven Sisters Falls, and growing degree days are 2581 and 2692 respectively.

Additional meteorological data is presented in Table 1.

1.4 VEGETATION

The Whitemouth Peatland lies totally within the Lower English River Section of the Boreal Forest Region. Mixed stands of trembling aspen, balsam poplar and white spruce provide the chief forest cover on the well drained sites. Other common boreal species, balsam fir, white birch, and jack pine are also present-the pine

frequenting the sandier soils as is usual but also extending to clayey and silty soils after fire. The peatlands are dominated by tamarack and black spruce. Green ash, white elm, and bur oak are found also along riverine sites.

The treed bog sites range from stunted black spruce and tamarack on more acid and wetter site, to good size trees on better drained sites (ie. lower water table). The shrub layer is dominated by ericaceous shrubs Ledum groenlandicum (Labrador-tea), Andromeda glaucophylla (bog-rosemary) and Chamaedaphne calyclulata (leatherleaf). Ground cover consists of Sphagnum spp. moss, feathermosses (Pleurozium schreberi, Hylocomium splendens), swamp cranberry (Vaccinium oxycoccus), and bog cranberry (Vaccinium vitis-idaea). The open fens are characterized by Carex spp, (Menyanthes trifoliata), pitcher plant (Sarracenia purpurea),sundew spp. (Drosera spp.) and brown mosses (Drepanocladus spp.).

While surveying the fen areas we encountered a rare orchid which we had only seen once before in the Sprague bog. This was the rose pogonia (Pogonia ophioglossoides). The denser populations of rose pogonias are denoted on the soil map by special shading.

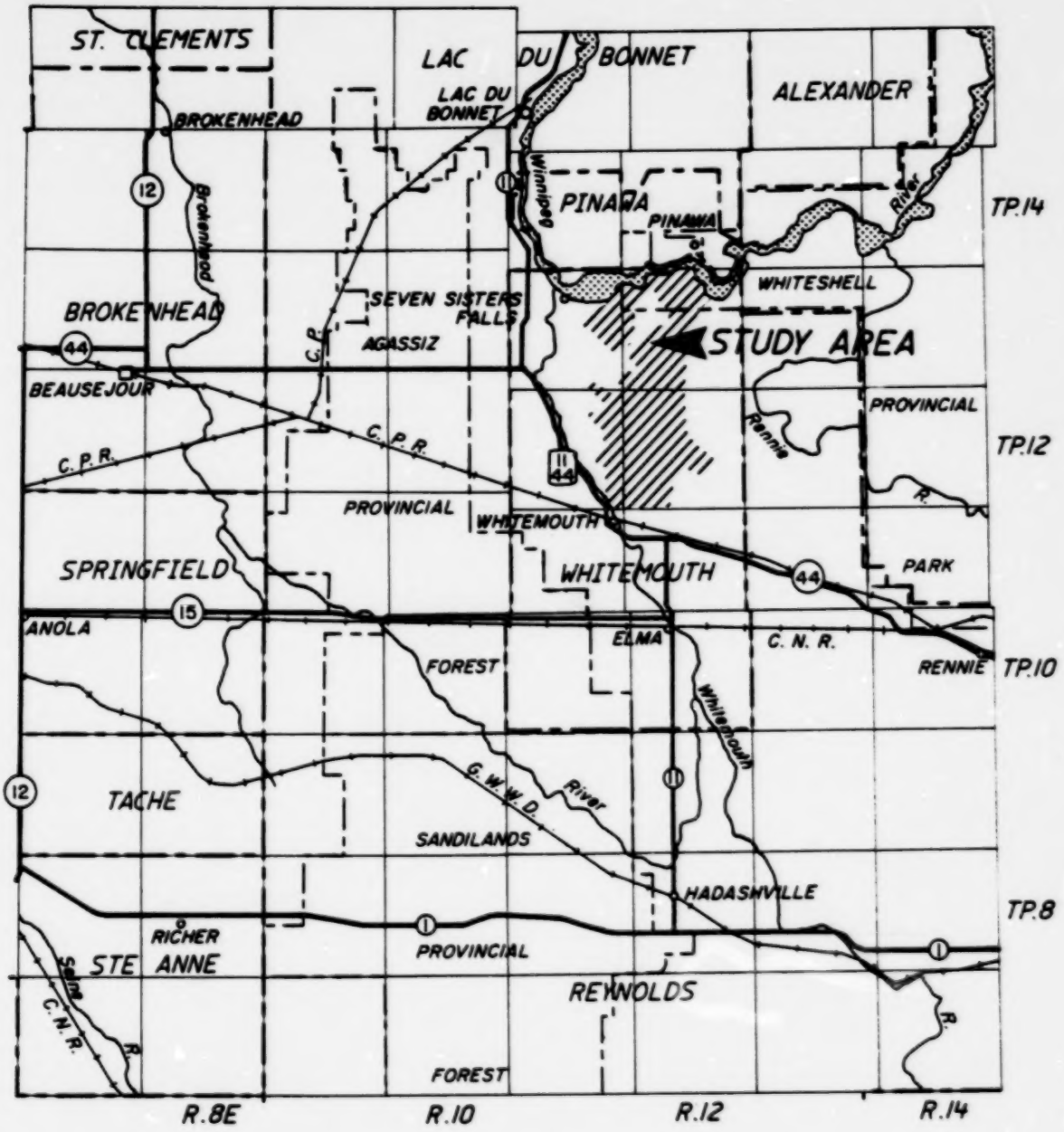

Figure 1: Location of Whitemouth Peatland.

Figure 2: Relief and Drainage of the Whitemouth Peatland.

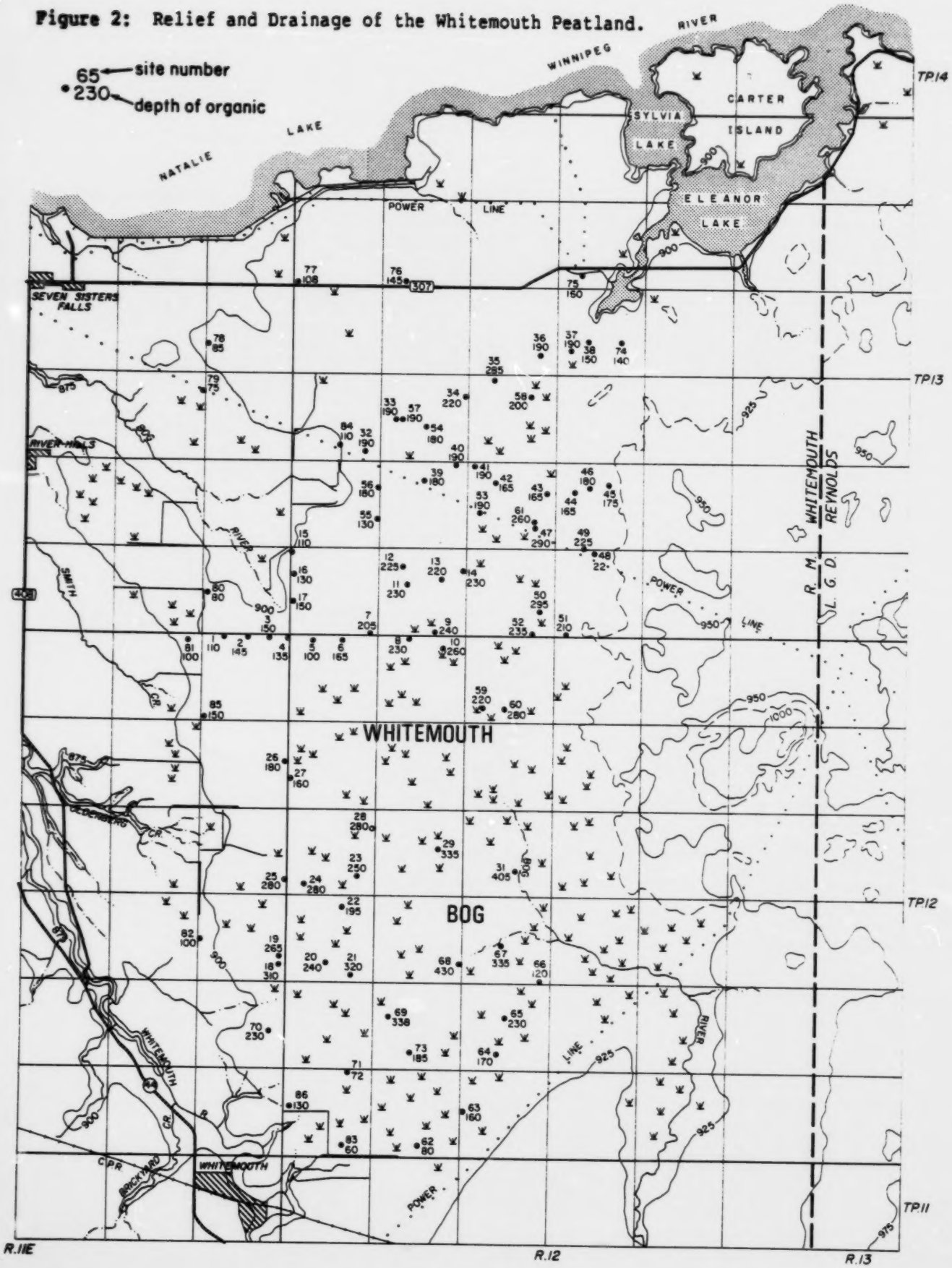

Table 1. Climatic Data from Recording Stations Located Near the Study Area

		Pinawa	Seven Sisters
Average Precipitation (mm)	Annual	412	416
	Growing Season May 1-Sept 30	347	345
Average Annual Temperature (^{o}C)		1.5	2.1
Average Frost Free Period (Days)		110	119
Average Date of	Last Spring Frost	May 29	May 22
	First Fall	Sept 17	Sept 23
Degree Days Above $0^{o}C$		2581	2692

Canadian Climate Normals, 1951-1980 (1982). Atmospheric Environment Service, Environment Canada Vol. 2 Temperature, Vol. 3 Precipitation, Vol. 4 Degree Days, Vol. 6 Frost.

PART 2

FORMATION, CLASSIFICATION AND MORPHOLOGY OF ORGANIC SOILS

2.1 ORGANIC SOILS

Definition

Organic soils have developed dominantly from organic deposits that contain 30% by weight or more of organic matter and that have minimum depths of consolidated organic material as defined by The System of Soil Classification for Canada (Can. Dep. Agric. 1970). Organic soils consist of organic residues accumulated from the cyclical growth and decay of hydrophytic vegetation common to marshes, swamps, fens, and bogs. The majority of organic soils are saturated for most of the year or are artificially drained, but some are not saturated for more than a few days.

Peat materials

Five main types of peat have been recognized in the Peatland. These peats, which are the parent materials of organic soils in the area, are sphagnum peat, forest peat, forest-fen peat, fen peat, and aquatic peat. Each kind develops under distinct ecological conditions largely governed by climate, physiography, chemistry of the groundwater, and nature of underlying or surrounding mineral soil materials.

Sphagnum peat. Sphagnum peat forms on very wet ombrotrophic or nutrient-poor sites, which are isolated from mineral-influenced groundwater. This type of peat occurs under open stands of stunted black spruce and tamarack (black spruce-sphagnum mosses-Labrador-tea or pure sphagnum mosses - Labrador-tea communities). The main peat source in these communities is sphagnum mosses, with smaller components of feather-mosses and stems and leaves of ericaceous shrubs. It may contain woody intrusive material such as roots and stems of black spruce.

Sphagnum peat is usually found in a fibric, or well preserved condition. It is usually light yellowish brown to very pale brown in color, loose and spongy in consistency, and contains easily recognizable, whole sphagnum plants. At lower depths, sphagnum peat becomes a reddish yellow to dark brown, compacted, horizontally layered, fibric material. It usually has a unrubbed fiber content of 95%, which decreases to about 80% when rubbed. It is usually extremely acid (pH less than 4.5). Bulk density values are usually less than 0.1 g/cm^3

Forest peat. The type of organic material recognized as forest peat usually forms on slightly better drained minerotrophic or nutrient-rich, sites on the slopes of bogs, near or at mineral soil boundaries. It usually occurs under productive stands of black spruce (black spruce - feathermoss; black spruce - Labrador-tea - mixed moss communities), or forests of cedar or mixed cedar and black spruce. It is also found under less productive communities of black spruce, tamarack, sedges, and mixed mosses.

Forest peat usually has a very dark brown to dark reddish brown matrix and an amorphous to very fine fibered structure; it may have a somewhat layered macrostructure. The nonsticky to slightly sticky material is interspersed at random with coarse to medium-sized woody fragments or particles from the roots, stems, and needles of black spruce and tamarack. There are often intrusive layers of larger woody particles from the stems and roots of spruce and tamarack deposited as a result of cyclical fire history.

Forest peat is usually mesic, with an unrubbed fiber content (particles less than 0.15 mm) of about 60%, which decreases to about 25% when rubbed. Some forest peats associated with cedar vegetation are well decomposed, or humic. These materials are usually base saturated and moderately acid to neutral (pH 5.9 to 7.3). The matrix is fairly dense throughout; the bulk density is usually greater than 0.1 g/cm^3 and becomes greater as the depth increases.

Forest-fen peat (woody-fen peat). Forest-fen peat forms on very wet, weakly minerotrophic sites that support tamarack-fen vegetation (tamarack - sedges - mixed moss communities).

The matrix of the material is usually moderately well decomposed and has a fine, fibered, felt-like appearance. Wood content is usually intermediate between that of forest peat and fen peat.

Fen peat. The type of organic material classed as fen peat develops in very wet fens influenced by minerotrophic groundwater. The vegetation of such sites is characteristic of sedges - aquatic mosses, sedges - aquatic mosses - dwarf birch or willows, or aquatic mosses -

This peat is usually moderately well decomposed, or mesic, dark brown to very dark brown, and fine to medium fibered with a horizontally matted or layered structure. More decomposed fen peat is very dark brown to black,compacted, and fine fibered to amorphous. In many soils the surface layer (20 to 30 cm) is fibrous and well preserved; decomposition is greater at lower depths. Moderately well decomposed fen peat is nonsticky to slightly sticky; the well decomposed, or humic, material is slightly sticky. Unrubbed fiber content of mesic fen peat is about 40 to 60%, decreasing to 20 to 40% when rubbed. More decomposed material usually has an unrubbed fiber content of less than 30% and a rubbed fiber content of less than 10%. Fen peat is usually moderately acid to neutral (pH 5.6 to 7.3). The moderately well decomposed material is fairly dense, with a bulk density usually greater than 0.1 g/cm$_3$ The more decomposed material has greater density and compaction, with a bulk density usually greater than 0.2 g/cm^3

Aquatic peat. Aquatic peat occurs as basal layers in deep basins and originates in lakes or ponds. The material is usually finely divided but poorly decomposed, amorphous, black, fairly dense, and compacted. Aquatic peats include all the aquatic oozes and peats such as gyttja, sedimentary peat, and copropel.

Classification

The Organic soil classification as outlined in The System of Soil Classification for Canada (Can. Dep. Agric. 1970) was used to classify the organic soils of the Whitemouth Peatland into great groups, subgroups, families, and series (Table 2). Organic soil classification is based chiefly on the interrelationships of

the main organic peat materials within an arbitrarily selected control section, their depth and degree of decomposition, and the texture of the underlying mineral materials. The control section extends from the surface to a depth of 160 cm and is divided into the surface, middle, and bottom tiers (Figure 3). If the underlying mineral materials occur below the middle tier, the subgroup classification is based on the dominant kind of peat material found in the middle tier; if the mineral contact occurs in the middle tier, the classification is based on the dominant peat material in the middle and surface tiers.

The basic unit in the system of soil classification in Canada is the soil series. A soil series is defined as a naturally occurring soil body such that any soil profile within the body has a similar number and arrangement of horizons or layers and whose color, texture, structure, consistence, thickness, reaction, and composition, or a combination of these, are within a narrowly defined range.

Organic soils are classified at the series level according to the characteristics that are considered to have most influence on capability and use for various purposes. The following characteristics were used to recognize and differentiate individual soils at the series level.

1. The dominant or subdominant kinds of organic peat materials, or both, within the control section.

2. The degree of decomposition of the organic materials.

3. The depth of organic materials overlying mineral or bedrock substrates.

4. The texture of the underlying mineral materials.

5. The soil climate (thermal regime).

Organic soil series may be divided into phases, to indicate more closely the properties that may be significant to man's use or management of organic terrain. Soil phases indicating depth to the substrates in Terric and Lithic subgroups, conditions of hummocky microrelief caused by burnouts, and areas of improved drainage.

Soil series and soil phases are three-dimensional bodies that occupy a geographical place in the landscape. Because soil is a continuum, there are often no sharp boundaries between series. However, we need to identify, sample, and describe these bodies so their properties can be compared and predictions can be made about their use and management. Therefore, limits have been placed on the variations allowed in the characteristics that differentiate these bodies. The limits are broad enough so that the series or phases cover areas sufficiently large to be mapped. Usually, because time and mapping scale are restricted, it is impractical to draw exact boundaries between one soil series and another. Consequently, each delineated area may contain a small proportion (less than 15%) of other soil series. It can be seen that the concept of a soil series as a taxonomic unit is related to, but is not exactly the same as, the soil body delineated on a map.

Table 2. Classification of the organic soils as mapped in the Whitemouth Peatland according to The System of Soil Classification for Canada (1987) Sec. Ed.

Order	Great group	Subgroup	Soil family	Series
Organic soils	Fibrisol	Mesic fibrisol		
Soils developed dominantly from organic deposits that are saturated for most of the year, and contain 30% or more of organic matter to: 1. a depth of at least 60 cm if the surface layer consists dominantly of fibric moss; or 2. to a depth of at least 40 cm for other kinds or mixed kinds of organic material; or 3. to a lithic contact if it occurs at a depth greater than 10 cm but less than either 40 or 60 cm	Organic soils with a dominantly fibric middle tier, or middle and surface tiers if a terric, lithic, or hydric contact occurs in the middle tier.	Fibrisols with dominantly fibric middle tier and a subdominant mesic layer thicker than 25 cm in the middle or in the bottom tier. Other layers are absent.	Sphagnic, dysic, cold, aquic	Whithorn
	Mesisol	Typic mesisol		
	Organic soils with a dominantly mesic middle tier, or middle and surface tiers if a terric, lithic, or hydric contact occurs in the middle tier.	Mesisols with dominantly mesic material throughout the middle and bottom tiers. The control section lacks any terric, lithic, hydric, cumulo, or limno layers.	Mesic, euic, cold, aquic	Stead Overflowing
			Sphagnic, euic, cold, aquic	Katimik Waskwei
		Terric mesisol		
		Mesisols with a terric layer beneath the surface tier. Cumulo or limno layers may be present but other layers are absent.	Mesic, euic, cold, aquic, clayey	Cayer
			Sphagnic, euic, cold, aquic	Orok

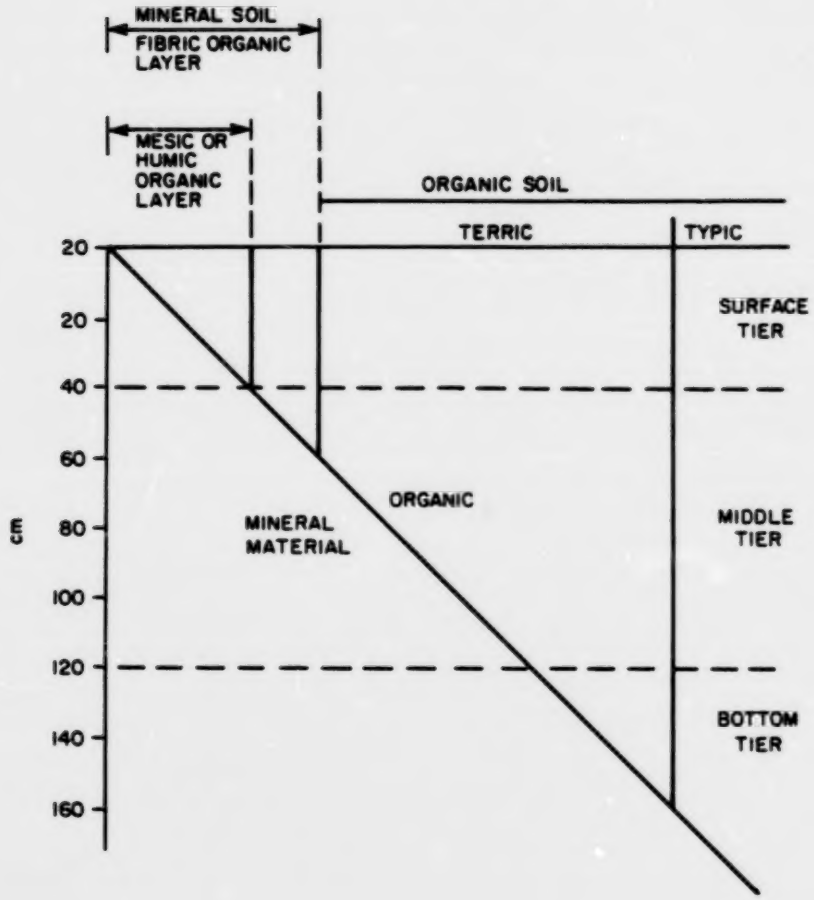

Figure 3: Diagrammatic representation of depth relationships involved in Organic soil classification.

Organic terrain often has a complex pattern of landforms and large variations in soil properties over short distances. In such terrain, two or more soil series often occur in such an intricate mixture that it is not practical to show them separately on the map. Such mixtures of soils in the peatland are shown as one mapping unit and called a soil complex. The proportion of each soil series in a complex is indicated on the soil map in deciles.

Soil mapping

Field work was carried out between July and October, 1985. Ground control was restricted to cut survey lines and winter roads in the forested part of the peatland; open treeless areas were surveyed on a more systematic grid system. A J-5 bombardier tracked vehicle was used for transportation. The soils were examined at frequent intervals on the traverses, and the frequency was determined by soil variability in the area. Inaccessible parts of the peatlands were mapped by extrapolation from the areas through which traverses had been made. During the field studies, the following information was collected.

1. Characterization of the dominant organic soil series or complexes and delineation of their areal extent.
2. Vegetative characteristics associated with each soil and organic landform.
3. Drainage characteristics of the peatland
4. Chemistry of the surface waters
5. Topography of the peatland.
6. Depth of organic materials to the underlying mineral strata.
7. Nature of underlying mineral materials.

The field information was plotted on panchromatic black and white aerial photographs at a scale of 1:50,000 and transferred photomosaic to a map manuscript at a scale of 1:50,000.

2.2 DESCRIPTION OF SOIL SERIES AND MAPPING UNITS

Seven soil separations have been recognized and mapped at the series and phase level. The organic soil series and associated poorly drained mineral soils are described in alphabetical order, with a general description of the profile type, organic parent material, and associated vegetation. Detailed morphological, chemical, and physical data are presented for four of the soils series in Appendix E.

Acidic Bedrock (aR)

The acidic bedrock consist dominantly of granitoid rock outcrop. Most of the mineral soils at the edge of the bedrock outcrop have been developed on loamy to clayey lacustrine sediments over bedrock. The topography varies from steeply sloping to irregular gently sloping. The native vegetation varies mainly with drainage and consists of jack pine on the rocky knolls, mixed stands of aspen, jack pine, white spruce, balsam fir and white birch on the more moist mineral soil sites and black spruce and tamarack on wet organic soils.

Cayer Series (CAY)

The Cayer series consists of very poorly drained Terric Mesisols developed on shallow (40 to 160 cm) deposits of mesic fen peat. The surface layer of peat is usually fibric, and a thin layer of humic fen or aquatic peat or both occur above the mineral substrate loamy to clayey lacustrine sediment occur within 160 cm of the surface. The Cayer soils occupy level to depressional mesic horizontal fen landforms, usually near the mineral margin of a peatland. Vegetation is dominantly sedges and meadow grass with aquatic mosses; a woody herbaceous cover of willows and dwarf swamp birch occur on better drained sites.

Fyala Series (FYL)

The Fyala series consists of poorly drained Rego Humic Gleysol soils developed on weakly to moderately calcareous lacustrine clay deposits. At one time these soils were peaty phase or organic soil, but due to fire, they end up mineral soils. The Fyala soils are clay textured throughout the profile which occur adjacent to the poorly drained peatland areas (Whitemouth peatland) and along the creeks. Internal drainage in these soils is impeded by clayey textures and high ground water table. The native vegtation on these soils varies from mixture of black ash and balsam poplars with a few black spruce and balsam fir thrown in.

Katimik Series (KMK)

The Katimik soils are very poorly drained organic soils developed on deep (>160 cm) deposits of mesic fen or forest fen peat. This series consists of Typic Mesisols, sphagnic phase, in which a thin (15 to 60 cm), discontinuous surface layer of fibric sphagnum or mixed moss peat cover moderately well decomposed forest fen or fen peat or both. Loamy to clayey lacustrine sediments are known to underlie these soils.

The Katimik soils occur in broad somewhat concave, very poorly drained water tracks that traverse the peatland. The Katimik soils also occur in complex pattern of slightly raised black spruce tamarack islands and treeless fens in areas affected by slow moving minerotraphic groundwaters. The wooded islands lie parallel to water flow and are raised above the influence of the minerotraphic waters which allows the growth of bog vegetation and accumulation of sphagnum and forest peat. The associated soils in the intervening saturated fen areas are members of the Overflowing series. They are often found downslope from better drained, forested bog sites or as fringe areas next to saturated fens. The poor drainage on these sites restricts tree growth to stunted stands of tamarack. Native vegetation is dominantly tamarack with an understory of sedges and mixed mosses, some ericaceous shrubs such as leather-

leaf, Labrador tea, bog rosemary, and woody shrubs such as swamp birch and willows.

The soil chemical and physical attributes are found in Appendix E.

Orok Complex (OOKX)

The Orok series the dominant member of the Orok Complex consists of poorly to very poorly drained organic soils developed on a very thin (15 to 60 cm) discontinuous fibric sphagnum layer underlain by mesic forest peat. The Orok soils are underlain by loamy to clayey textured lacustrine sediments within 160 cm of the surface.

The Orok soils are found in areas of shallow peat accumulation near the peatland margins. Native vegetation is black spruce and some tamarack in the tree layer with an understory of ericaceous shurbs such as Labrador tea and bog rosemary. The ground cover consists of mixed mosses, mainly Sphagnum species in the form of pillows and hummocks.

Overflowing Series (OVO)

The Overflowing series consists of deep (>160 cm), very poorly drained organic soils developed on mesic fen peat. These soils are Typic Mesisols aquic phase, characterized by a thin surface mat (usually 10 to 30 cm) of fibric fen peat floating over a variable depth of water or semifluid peat materials between 30 and 100 cm from the surface. Consolidated mesic to humic fen peat occurs under the aquic layers to a depth of more than 160 cm. In this peatland the Overflowing soils are underlain by loamy to clayey lacustrine sediments.

Overflowing soils occur on aquic horizontal fens in the very poorly drained central parts of the peatland and in some cases represent very late stages of lake filling and accumulation of organic deposits. The topography of this soil is depressional to very gently sloping. Native vegetation is dominantly brown aquatic mosses; sedges occur on slightly better drained ridges.

Stead Series (STD)

The Stead series consists of very poorly drained organic soils developed on deep (>160 cm) deposits of mesic fen peat. These soils are Typic Mesisols characterized by very thin (10 to 30 cm) surface layer of fibric fen peat that is dark yellowish brown and medium acid to neutral. The surface layer covers very dark brown, medium acid to neutral, mesic fen peat, which can grade into black slight acid to alkaline, humic fen peat. In this peatland the Stead soils are underlain by loamy to clayey lacustrine sediments below 160 cm.

The Stead soils occur on mesic horizontal fen landforms in the peatland. They are commonly in the central parts of the peatland where peat accumulation is deep. Topography of these areas is depressional to level and the native vegetation is dominantly sedges and reeds with swamp birch and willow on slightly better drained sites. The site and soil characteristic of the Stead series are found in Appendix E.

Waskwei Complex (WKWX)

The Waskwei series the dominant member of the Waskwei complex consists of poorly to very poorly drained Typic Mesisols sphagnic phase, developed on deep (>160 cm) deposits of dominantly mesic forest peat. These soils are capped with a thin (15 to 60 cm), almost continuous surface layer of fibric sphagnum moss peat. They occur in areas of deeper organic accumulation. These landforms are beyond the influence of minerotrophic groundwaters, and poor drainage makes them suitable for the growth of sphagnum mosses. On these soils sphagnum mosses usually grow in the form of pillows or hummocks and provide a discontinuous surface cover. The Waskwei soils are underlain by loamy to clayey lacustrine sediments in this peatland.

The topography of the Waskwei soil is almost level with a hummocky microrelief of sphagnum moss pillows separated by wet depressions and bog pools. The native vegetation on these soils are black spruce forest, and the dominant species are black spruce with some tamarack in the tree layer. Labrador tea, leatherleaf, and sphagnum mosses with varying amounts of feathermosses occur in the understory. Where drainage is poor sphagnum species are more abundant and the forest cover is less productive. Merchantable dense stands of black spruce occur on these soils where the water table can recede to some extent. The soil characteristics of the Waskwei series are found in Appendix E.

Whithorn Complex (WHIX)

The Whithorn series, the dominant member of the Whithorn complex consists of Mesic Fibrisols developed on dominantly extremely acid fibric sphagnum moss peat with a subdominant layer or layers of mesic forest or forest fen peat between (90 and 160 cm) below the surface. This part of the organic section often consists of thin layers of fibric sphagnum peat alternating with thin layers of woody mesic forest or forest fen peat. More uniform mesic forest peat or mesic fen peat, or both usually occur below 120 cm in the organic section. Total thickness of the organic deposits in the Whithorn soils ranges from 2 to 3 meters in this peatland. The underlying sediments are stone free, loamy to clayey lacustrine sediments.

The Whithorn soils occur on domed and raised bogs in the peatland. These landforms occupy small area in the northern part of the peatland. These soils are well removed from the influence of minerotrophic groundwater. In this situation the rapid growth of sphagnum mosses results in large accumulations of peat and the formation of raised organic landforms.

Native vegetation on the Whithorn soils is stunted black spruce with an understory of Labrador tea, leatherleaf and sphagnum mosses. The sphagnum species grow in hummocks or pillows and cause a subdued microrelief. The site and soil characteristics of the Whithorn series are found in Appendix E.

PART 3

USE AND MANAGEMENT INTERPRETATIONS OF SOILS

3.1 ORGANIC SOIL CAPABILITY FOR AGRICULTURE

The organic soils in the Whitemouth Peatland have been rated for: (a) "potential" agricultural capability, and (b) degree of development difficulty involved in achieving this potential, after the method of Leeson, 1969[1]. This twofold approach to classifying organic soils recognizes that the agricultural suitability of most of these soils requires reclamation or development from their native state and that most organic soils in their native state have little or no value for agriculture. Rating degree of development difficulty takes into consideration intrinsic characteristics of the soils affecting development and also associated costs required for development.

The capability classes of organic soils established not only reflect potential for agricultural use but also identify the continuing limitation of these soils for agriculture after reclamation has been implemented or is assumed to have been implemented.

To date, in Canada, no national system has been adopted for classifying organic soils for agricultural capability. The system and approach taken in Manitoba is basically a modification of the mineral soil capability classification for agriculture.

The Canada Land Inventory seven class soil capability classification system provides a suitable framework wherein various kinds of organic soils may be placed in order to show their relative value for agriculture along with mineral soils. This single framework for evaluating organic and mineral soils is very important in view of the potentially large sums of public funds normally required to reclaim and develop organic soils. The development of mineral soils of equivalent agricultural capability normally does not require such expenditures and their management problems are usually such that they are within the capability of individual operators to overcome. A single framework embracing both groups of soils makes evaluations and recommendations for development of either group of soils more relevant.

While the above system may provide a framework for evaluating organic soils, it does not provide the guidelines and criteria necessary for adequate interpretive judgements. Leeson (1969)[2] outlines a system of rating organic soils, used in Ontario, reflecting their value for crop prodcution and their relative degree of difficulty of development. These

[1] Leeson, Bruce, et al. 1969. An Organic Soil Capability Classification for Agriculture and a study of the soils of Simcoe County. Soil Sci. Dept., Ont. Agric. College, Guelph, Ont.

[2] Ibid

guidelines and criteria have been adopted and modified to more adequately suit conditions in Manitoba.

Water table control is the major reclamation requirement for the agricultural development of organic soils. Optimum water table control is necessary both for successful crop production as well as the long term maintenance of the soil itself. Improper manipulation of the water regime of an organic soil area can result in loss of the organic soil base through increased rates of subsidence, potential irreversible physical damage to the soil and increased hazards of wind erosion and fire damage. With water control at optimum levels (usually 45 to 90 cm below the surface) for both crop production and minimal subsidence rates, soil loss through subsidence can continue at rates of 2 cm to 5 cm annually. In consideration of eventual loss of the organic soil base, the capability ratings, therefore, reflect the continuing use-capability of such areas based on the character of underlying mineral substrates. Shallow organic soil areas underlain by unsuitable mineral substrates would preclude their long term utilization as a productive land base and should not be reclaimed for agricultural use.

The evaluation of organic soils for agriculture is carried out in two steps. Firstly, the organic soils are placed in "Capability Classes". This rating indicates the agricultural potential of the soil according to any hazards which reclamation is unable to remove and which, therefore, constitute a continuing limitation to agricultural production. The second step recognizes that the agricultural use of most organic soils necessitates reclamation or development from the native state with varying degree of difficulty and associated economic costs. The relative degree of difficulty of carrying out development is expressed in a "Development Difficulty Rating" that is assessed in terms of those properties and qualities of organic soils that significantly influence reclamation. For example, the presence or absence of trees; the content of large wood fragments; the permeability, density, and degree of decomposition of peat; and natural water table conditions all exert a very significant influence on reclamation of peatlands.

Recommendations for the development of organic soils is, therefore, based on both the Development Difficulty Rating and their continuing suitability after reclamation.

The Capability Classification of Organic Soils for agriculture is based on certain assumptions which must be understood by those using Capability maps or making Capability Ratings for various crops.

1. Capability ratings for drained conditions assumes continued subsidence rates of 2 cm to 5 cm annually; hence, depth of the organic layer and the nature of underlying mineral substrate is taken into account in evaluating organic soils for agriculture.

2. The organic capability grouping is an interpretive classification designed to assess the limitation of individual organic soils to development for production of cereal grains, forage and pasturage.

3. Good soil management, including drainage, control of subsidence, wind erosion, crop growing and conservation practices that are feasible under a mechanized system of agriculture are assumed.

4. The soils within a capability class are similar with respect to the degree of soil limitation but

not necessarily similar with respect to the kind of limitation. The subclass provides information on the kind of limitation or hazard and the class indicates the intensity of the limitation. Organic soils in Class 1 have the least limitations and Class 7 have the most severe.

5. Organic soils which have been reclaimed and developed for agriculture are classified according to any continuing limitations which may affect the production of agricultural crops. Soils in the natural state are classified not only for the agriculture capability but also according to the apparent degree of difficulty in reclamation and development.

6. The location, distance to market, efficiency of transport, financial state of the market, farm size and sociological influences do not constitute criteria for capability groupings.

7. Capability classes and capability definitions are subject to change as new information and methods concerning the manipulation of organic soils become available. At the present time, capability groupings do not have the benefit of extensive regional research and management experience in their use for agriculture as in the case of mineral soils.

The Capability Classes and Subclasses

The seven Capability Classes for organic soils, together with guide numbers to aid in the proper placement of the soils, are given below:

Class O1 -Organic soils of this group have no water, topographical or pH limitations, and are deep and level. They are located in areas having mild or warmer soil temperatures.

Class O2 -Organic soils in Class 02 have no limitation which restricts their use in a minor way. The limitation may be soil temperature, coarse fragments, wood layers, salinity, depth or slope.

Class O3 -Organic soils in this class have moderately severe limitations that restrict the range of crops or that require special management practices.

Class O4 -Organic soils in this class have limitations which severely restrict the range of crops or which require special developoent and management practices.

Class O5 -Organic soils of this class have severe limitations that restrict the production of perennial forage or other specially adapted crops. Large scale reclamation is not feasible[3].

Class O6 -Organic soils in Class 06 are capable of producing only indigenous crops and improvement practices are not feasible.

Class O7 -Organic soils of this class

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[3] In the foregoing definitions the term feasible implies that it is within present day economic and technological possibility for an individual farmer to make such improvement and it does not require a major reclamation project to do so.

have no potential for agriculture.

To determine the capability rating for organic soils, the relative penalty values assigned to the applicable soil features as indicated in Table 3 are added together.

Capability Subclasses indicate the kind of problem limiting suitability for agriculture, Table 3. For example, if the only limitation a soil had was climate, a designation of 2c could be used or if depth was the limiting factor, 2d or 3d could be used to indicate that depth was the limitation. Usually, no more than two subclass limitations are used to describe a soil. If the cumulative severity of more than two limiting features necessitates placement in Capability Class 04 or lower, only the two major limiting factors are indicated.

Development Difficulty Ratings for Organic Soils

In addition to evaluation of potential capability, an attempt was made to rate relative degree of difficulty of carrying out reclamation or development on organic soils. These ratings are based on evaluations of the present or natural state of organic soils. The Degree of Development Difficulty ratings are important in priorizing areas of organic soils for reclamation. Three relative degrees of difficulty in overcoming limitations or hazards to use are recognized.

1. Minor Development Difficulty

   Only minor reclamation is required to overcome limitations to use. Minor reclamation is considered to be those operations which can be carried out by a single operator and which do not require cooperation between adjoining operators. Such operations would include leveling rough surfaces, removal of surface woody layers and land clearing.

2. Major Development Difficulty - Reclamation Warranted

   Major reclamation is required but is warranted when soil potential is high. Major reclamation is that requiring cooperation between adjoining operators or outside financial assistance or both. Major reclamation operations include drainage, construction of water control works or correction of very low pH or very high pH.

3. Major Development Difficulty - Reclamation Seldom Warranted

   These organic soils can be developed only by very large reclamation projects. Major reclamation is seldom warranted here because the hazards are so serious that they constitute some continuing limitation which reduces the agricultural capability.

Many features of organic soils which affect their agricultural capability also affect the degree of development difficulty experienced in reclaiming organic soils and the relative costs associated with maintaining their productive capacity. The relative importance of these soil properties may be adjusted when considering development difficulty. In addition, factors such as vegetative cover, inundation and surface roughness must be evaluated. The features of organic soils important to the evaluation of degree of development difficulty ratings are listed in Table 4. The rela-

tive limitation of each feature to reclamation is often related to organic materials and soil types; in other cases, the relationship is with the physiographic position of the soil area relative to other organic and mineral soils. In all cases, the applicable feature is ranked by means of penalty values as to its relative effects on development difficulty.

To determine the relative degree of development difficulty the penalty values for the features applicable to each soil are added together and subtracted from 100. This figure is used as a guide by comparing with the following ranges for each degree of development difficulty group. The following ranges of penalty values for each group were used in the Whitemouth peatland:

Minor	>70
Major - Reclamation Warranted	25-69
Major - Reclamation Seldom Warranted	<24

The Agriculture Capability and Degree of Difficulty Ratings for the Organic Soils in the Whitemouth Peatland (Table 5)

Class O3

Organic soils in this class have moderately severe limitations that restrict the range of crops that can be grown or that require special development and management practices.

O3W - These are poorly to very poorly drained soils that are derived from moderately decomposed fen peat. These smooth, level organic deposits range in depth from 50 cm to 160 cm. They are normally very uniform with respect to degree of decomposition and nature of plant residues from which the peat has been derived. They usually range from medium acid to neutral in reaction and have a high water holding capacity. Movement of water in these organic soils is moderately slow and is similar to that in a uniform, medium textured mineral soil. They are usually underlain by calcareous, clay textured lacustrine sediments.

The shallow member of this group, Cayer, has a minor degree of development difficulty rating. In the case of these soils lowering and controlling the water table between 18 and 36 inches of the surface is not a major reclamation problem. The soil in this subclass is the Cayer Series.

Class O4

Organic soils have severe limitations which restrict the range of crops or which require special development and management practices.

O4W - These are poorly to very poorly drained soils that are derived from moderately decomposed fen peat. The soils in this subclass are Stead series and Katimik series. The smooth level, organic deposits are deeper than 110 cm. Their degree of decomposition and the nature of plant residues from which the peat has been derived are normally very uniform. These soils usually range from medium acid to neutral in reaction and have a high water holding capacity. Water movement is moderately slow and equivalent to that in a uniform, medium textured mineral soil. They are usually underlain by loamy to

clayey textured lacustrine sediments.

The deeper Katimik and Stead soils are rated as having a major degree of development difficulty. Most of these soils normally occur in the center of large peatland areas and usually serve as catchment basins to adjacent shallow organic and mineral uplands soils. Because of this, major reclamation is required to remove large volumes of water. The soils in this subclass are: Stead Series and Katimik Series.

4WL - These poorly drained organic soils are derived from moderately well to well decomposed forest peat. These densely tree covered, hummocky surface, woody organic deposits range in depth from 1 m to more than 3 m in thickness. They are usually found on slightly better drained, upslope or very gently sloping to nearly level sites near the margins of peatlands.

Forest peat is derived from black spruce, some tamarack, feathermosses, some ericaceous shrubs and other herbaceous plants. The peat material is usually very dark brown to nearly black in color, amorphous in structure with variable layers of coarse, woody fragments, black spruce and tamarack roots, stems and branches. The peat is usually strongly acid to neutral in reaction. Water movement in these soils is variable, being moderately slow to slow in the dense well decomposed layers and very rapid in the coarse, woody, less well decomposed layers. The underlying fine textured lacustrine soils are smooth and usually moderately calcareous.

These soils have a major degree of development difficulty rating because of the dense forest cover, excess water from surrounding uplands, their hummocky surface, and most important the rather high content of coarse woody material in the material itself. This woody material is much more resistant to decomposition than herbaceous material and contributes significantly to rough and uneven seedbed. The high degree of decomposition in some layers of these soils contribute to poor water movement in these soils and consequently impart a further limitation to the control of water table at 45 to 90 cm of the surface. The soils in this subclass are Orok Series and Waskwei Series.

Class 05

Organic soils of this class have severe limitations that restrict use of these soils to production of perennial forage or other specially adapted crops.

Class 06

Organic soils in this class are capable of producing indigenous crops and improvement practices are not feasible.

06WF -These poorly drained organic soils are derived from thick layers of extremely acid, relatively undecomposed Sphagnum moss that commonly overlie smooth, clay textured, calcareous sediments. These organic deposits are usually found on sites that are isolated from mineral influenced groundwater. These soils occur under open stands of stunted black spruce and tamarack. Sphagnum mosses and ericaceous shrubs such as

bearberry and Labrador tea form the dominant vegetation.

Sphagnum moss peat is usually found in a well preserved or fibric state. It is usually light yellowish brown in color, loose in the near surface layers and entire Sphagnum plants are readily identified. The material is usually extremely acid to very strongly acid. At lower depths, Sphagnum peat becomes reddish yellow to dark brown in color, extremely to strongly acid, compacted, horizontally layered and has a very low volume weight. This material contains some woody material. In thick deposits, those ranging from 1.5 to more than 3 meters, the Sphagnum is often underlain by forest and/or fen peat. Nutrient supply for plant growth is very low in these soils. Water movement, particularly in the surface layers, is very rapid.

The degree of development difficulty rating is major and normally development is not feasible since the value of these soils for agriculture is not high. The soil in this subclass is the Whithorn Series.

Class 07

Organic soils of this class have no potential for agriculture.

07W - These poorly drained organic soils are derived from fen peat which have a floating mat or a hydric layer below the surface mat which fluctuates rapidly with water flows. In such soils it would be impossible to regulate the water table if the surface mat is always floating. The soil in this subclass is Overflowing.

Table 3. Soil Properties Utilized to Determine the Capability Classification of Organic Soils

Symbol	Soil Property and Guidelines to Use	Penalty Value
C	THERMAL REGIME - soil temperature classes as defined in the Revised System of Soil Classification for Canada (1973)	
	Mild — MAST 8-15°C, MSST 15-22°C	0
	Cool — " 5-8°C, " 15-18°C	0
	Cold — " 2-8°C, " 8-15°C	35
	Very Cold — " -7-2°C, " 5-8°C	60
	Extremely Cold — " < -7°C, " < 5°C	90
W	EXCESS WATER - refers to groundwater level and flooding	
	Adequate: drainage provided for optimum crop yields and a water table sufficiently high to prolong the life of the soil (45 to 90 cm).	
	Marginal: less than adequate; yields reduced and choice of crops reduced (water table 30 to 45 cm or 90 to 120 cm).	35
	None: no control measures (water table <30 cm or >120 cm)	55
L	COARSE WOOD FRAGMENTS (Wood >4" dia., volume % within depths of 130 cm).	
	None — Fen peat, <1%	0
	Moderate — Forest-Fen and Sphagnum peats, 1-5%	10
	High — Forest peat, >5%	25
H	DEGREE OF DECOMPOSITION - as related to permeability	
	Mesic forest-fen and forest peat	0
	Mesic to humic forest peat	10
	Fibric sphagnum peat and humic aquatic peat	20
F	NATURE OF SURFACE MATERIALS - fertility as related to soil reaction	
	Forest, forest-fen and fen peats, pH 4.5 to 7.5	0
	Sphagnum peats, pH <4.5	20
	Fen peats with pH >7.5	10
N	SALINITY	
	None - conductivity 0-4 mmhos/cm	0
	Slight - conductivity 4-8 mmhos/cm	20
	Moderate - conductivity 8-12 mmhos/cm	50
	High - conductivity 12-16 mmhos/cm	75
	Excessive - conductivity >16 mmhos/cm	80

Table 3. (cont'd)

Symbol	Soil Property and Guidelines to Use	Penalty Value
D	DEPTH OF ORGANIC MATERIALS AND NATURE OF UNDERLYING SUBSTRATE*	
	Deep to very deep deposits underlain by sandy, loamy or clayey stone-free lacustrine sediments	0
	Shallow deposits underlain by loamy lacustrine sediments	0
	Shallow deposits underlain by clayey lacustrine sediments	10
	Shallow deposits underlain by sandy lacustrine sediments	20
	Shallow to very deep deposits underlain by skeletal loamy till, marl or diatomaceous earth	30
	Shallow to very deep deposits underlain by bedrock	50

* Penalty values for shallow depth of organic materials relates to the eventual loss of the land resource through subsidence. Shallow organic soils underlain by clays, sands, stony till, marl or bedrock have varying capability for agriculture when the organic layer has disappeared. These soils are therefore downgraded for the nature of the underlying mineral material, as well as for shallow depth.

Table 4. Physical Features Utilized to Determine Development Difficulty Rating of Organic Soils

Symbol	Physical Features and Guidelines to Use		Penalty Value
V	Vegetative Cover - Light, grasses, reeds		0
	Moderate, brush, small trees		10
	Heavy, numerous large trees		20
W	Excess water - Underground seepage and surface runoff from surrounding highlands into undrained depressional organic soil areas	Upper slope, marginal sites and raised central portion of peatlands	10
		Depressional catchments	20
		Floating peatlands	40
I	Inundation - Overflow from nearby large bodies of water or poorly defined rivers		
	None		0
	Slight		10
	Severe		20
T	Surface Roughness - Mounds, hummocks, ridges and holes		
	None		0
	Holes & mounds 25-50 cm microrelief		10
	Holes and mounds >50 cm microrelief		20
L	Coarse Wood Fragments - Wood 10 cm diameter, percent by volume within depths of 130 cm		
	<1%	Fen peat	0
	1-5%	Forest-Fen peat, Sphagnum peat	10
	>5%	Forest peat	20
H	Degree of Decomposition - permeability and hydraulic conductivity		
	Mesic	Fen peat	0
	Mesic to Humic	Forest peat	10
	Fibric	Sphagnum Peat	20
	Humic	Aquatic Peat	20
D	Depth of Organic Materials - Shallow to deep 30 to 160 cm		0
	- Very deep	>160 cm	20

Table 5. Agricultural Capability Classification and Developmental Difficulty Ratings for the Soils of the Whitemouth Peatland

Symbol	Name	Organic Agric.** Capability	Major Subclass Limitation	Developmental Difficulty
aR	Acidic bedrock	7R		
CAY	Cayer Series	03	W	1
FYL*	Fyala Series	3	W	
KMK	Katimik Series	04	W	1
OOKX	Orok Complex	04	WL	2
OVO	Overflowing Series	07	W	3
STD	Stead Series	04	W	2
WHI	Whithorn Complex	06	WF	2
WKWX	Waskwei Complex	04	WL	2

* mineral soil

** Capability classification of organic soils are preceeded by "O" and followed by a - numeral indicating the relative degree of development difficulty.

3.2 FORESTRY

Forest Land Use Capability Classification

The soils of the Whitemouth Peatland area are classified according to their capability to produce forest crops. The best forest lands are those capable of producing the greatest volume of a variety of regionally adapted species, and the poorest lands are those capable of supporting low volumes of a few species. Medium classes produce moderate volumes of several species, or can grow relatively high volumes of a few species only.

Mensuration of the forests in the map area was carried out during the Canada Land Inventory forest capability study of the Pointe Du Bois map sheet[4]. Productivity measurements were obtained from the best observed stands and individual trees on the major soil types within the map area or in the immediate vicinity. These productivity figures were extrapolated to similar soil types for which mensurational data did not exist by relating the forest capability maps to the soil map.

The forest land use capability is expressed in seven classes. Each class is characterized by a range of mean annual increment in gross merchantable cubic meters of wood volume per hectare, as defined by the Canada Land Inventory program[5]. Subclasses, based on factors that limit tree growth, follow the Canada Land Inventory definitions. Subclass symbols, when shown, always represent a limitation to growth and are used only when the limitations they represent affect the class level. When the limitations are advantageous or not severe enough to affect class level, they are not shown. The subclass definitions are as follows:

Climate

A limitation denoting a significant adverse departure from what is considered the median climate of the region, that is as a result of local climate; adverse regional climate is expressed by the class level.

Subclass A Droughty or arid conditions as a result of climate.

Subclass C A combination of more than one climatic factor or when it is not possible to decide which of two or more features of climate is significant.

Subclass H Low temperature or short growing season.

Subclass U Exposure.

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[4] Zoltai S.C. 1972. Land Capability for Forestry, Pointe Du Bois Map Sheet Area 52L. Canada Dept. of Fisheries and Forestry, and Canada Land Inventroy Project, Manitoba Dept. of Mines, Resources and Environmental Management.

[5] McCormack, R.J., 1970. Land Capability Classification for Forestry. Report No. 4, 2nd Edition. Department of Forestry and Rural Development.

Soil Moisture

A limitation denoting a soil moisture condition less than optimum for the growth of commercial forests but not including inundation.

Subclass M Deficiency of soil moisture during at least part of the growing season. The moisture deficit is generally due to the coarse texture of the soil, shallowness of soil over bedrock, or slope.

Subclass W Excess of soil moisture during at least part of the growing season. Excess moisture is generally due to slow internal drainage caused by fine texture of the soil, either on the surface or in layers, high water table in depressions, or low surface slope gradients.

Subclass X A pattern of "M" and "W" too intimately associated to map separately.

Permeability and Depth of Rooting Zone

Denotes limitations of soil permeability or physical limitation to rooting depth.

Subclass D Physical restriction to rooting caused by dense or consolidated layers other than bedrock.

Subclass R Restriction of rooting zone by bedrock.

Soil Factors

Denotes factors of the soil which individually or in combination, adversely affect growth.

Subclass F Insufficient supply of nutrients for optimum growth.

Subclass I Periodic inundation by rivers or lakes.

Subclass L Nutritional problems associated with high levels of carbonates.

Subclass N Excessive levels of soluble salts in the soil.

Forest capability in the Whitemouth Peatland map area is affected by over-riding climatic limitations. The fairly short growing season, low precipitation, occasional droughts and fairly high evapotranspiration combine to make Class 3 the highest rating in the area.

In addition to climatic limitations, various combinations of soil and landscape features affect forest productivity in the map area. One of these conditions is associated with the occurrence of free lime carbonate in the soils. The effect of such high levels of carbonates is to restrict soil profile development and inhibit the decomposition of non-calcareous rock fragments. In addition, accumulation of organic matter is restricted to a much shallower depth than for less calcareous soils. Organic matter is largely concentrated in the surface 15 cm in highly calcareous soils. In contrast, organic matter accumulates to greater depths in soils developed on less calcareous parent materials.

In addition to its effect on soil morphology, high levels of free lime are associated with nutritional problems which are not so evident in cul-

tivated agricultural crops receiving annual applications of nutrients required for plant growth.

Calcium is an essential plant nutrient for tree growth, but excessive amounts of lime carbonates in a soil may aggravate or disturb the soil nutrient balance through the activity of the $CaCO_3$ and the associated soil pH. At pH levels above 5.5, phosphates are adsorbed on to clay surfaces making them somewhat unavailable to plants. With increasing pH, phosphate solubility is gradually controlled by reactions with calcium in which it is adsorbed on to calcite crystals and precipitates in a form that is mostly unavailable. In addition to reaction with phosphates, excess lime may induce deficiencies in iron, manganese, copper, zinc and boron.

Other soil factors affecting forest capability in the Whitemouth map area are associated with soil drainage, and restrictions to rooting depth resulting from dense soil materials or bedrock. Seasonal soil moisture deficit limits forest growth on well drained sand and gravel ridges and soil moisture excess limits productivity on most poorly drained soils. Local areas of limestone bedrock near the surface restrict rooting depth and reduce productivity.

Soil Capability for Forestry

A description of the soils and their properties affecting capability is given in the following section.

Class 1

On these lands there are no important limitations to the growth of commercial forest. The productivity is greater than 7.8 cubic meters per hectare per year. No soils in the Whitemouth area are listed in this class.

Class 2

On these lands there are slight limitations to the growth of commercial forests. Productivity is between 6.4 and 7.7 cubic meters per hectare per year. No soils in the Whitemouth Peatland area are listed in this class.

Class 3

Lands in this class have level to gently sloping relief, are well to imperfectly drained, have good water holding capacity and are high in inherent fertility. Productivity is between 5 and 6.3 cubic meters per hectare per year. No soils in the Whitemouth Peatland are listed in this class.

Class 4

Lands in this class have moderately severe limitations to the growth of commercial forest. Soils have level to gently sloping relief and are poorly to well drained. Conditions of slight excess or lack of soil moisture, dense soil layers, insufficient nutrient supply or regional plant succession limit tree growth per hectare per year. No soils in the Whitemouth Peatland are listed in this class.

Class 5

Lands in this class have severe limitations to the growth of commercial forests, soils may have level to gently sloping and low ridge and swale topography and are well to poorly drained. Serious limitations to tree growth are imposed by low nutrient levels of the soil and seasonal lack or excess of soil moisture. The productivity is usually betweeen 2.2 and 3.5 cubic meters per hectare per

year. No soils in the Whitemouth Peatland area are listed in this class.

Class 6

Lands in this class have severe limitations to the growth of commercial forest which are imposed by low fertility related to high acidity, or soils that are shallow to bedrock or that have problems related to poor drainage. Productivity is between 0.8 and 2.1 cubic meters per hectare per year.

Subclass 6W The soils in this subclass and developed on poorly to very poorly drained mesic forest peat deposits, where the permanent water table is near the surface. The soils in this subclass are Orok and Waskwei Series.

Class 7

Lands in this class have very severe limitations that preclude the growth of commercial forest because of excess wetness, periodic inundation, exposure, excessive salinity, lack of rooting zone over bedrock, or lack of soil moisture. Productivity is less than 0.8 cubic meters per hectare per year.

Subclass 7W The soils in this subclass are developed on level, poorly or very poorly drained mesic sedge peat deposits, where the permanent water table is very near to the surface. Excessive wetness precludes tree growth. The soils in this subclass are Cayer, Stead and Overflowing.

Subclass 7WF The soils in this subclass are developed on level, poorly or very poorly drained fibric sphagnum moss peat deposits. The growth is very severely limited by excess of soil moisture and low natural fertility, allowing only the growth of stunted black spruce and some tamarack. The soils are Katimik and Whithorn Series.

3.3 ENGINEERING

Engineering Uses of the Soils

This section provides information for use by engineers and land use planners concerned with engineering and related geotechnical aspects of soil.

Soil properties considered highly important in engineering are permeability, strength, compaction, drainage characteristics, shrink-swell potential, grain size, plasticity and reaction (pH). Also important are depth to the water table, depth to bedrock, and slope. Various combination of these properties affect to varying degrees, the construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds, small dams and systems for disposal of sewage and refuse.

The criteria used to evaluate soil suitability for selected engineering uses are adopted from guides found in Coen et al[6], and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[7] and the Canada Soil Survey Committee[8].

The suitability of the various soils for selected engineering uses is given in Table 6.

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management. When conditions of use and management are not the same as those defined here, new guides should be established and appropriate revisions made in Tables 8 to 17 in Appendix D.

2. Soil ratings do not include site factors such as distance from towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify soil limitations. The use of soils rated as poor depends on the nature of the limitations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

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[6] Coen et al, 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[7] USDA, 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service USDA. SCS-45. 87pp.

[8] CSSC, 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357pp.

6. Interpretations of map units do not eliminate the need for onsite evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for, or importance of onsite studies depends on the use to be made of the soil and the kinds of soil problems involved.

Definition of Soil Suitability Classes

Evaluation of soil suitability for both engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soil series which are employed to described mapping units. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long-term effects of the potential use on the behaviour of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good	Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.
Fair	Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be over come with special construction, design, planning or maintenance.
Poor	Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require either the removal of the limitation or difficult and costly alteration of the soil or special engineering design or intensive maintenance to overcome the limitation.
Very poor	Soils have one or more features so unfavorable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering and recreation uses are in Table 7. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Table 6. Suitability Ratings of Soils for Selected Engineering and Recreation Uses

Map Symbol and Phase	Soil Name	Top Soil (1)	Sand & Gravel (2)	Road Fill (3)	Permanent Bldgs. With Basements (4)	Local Roads and Streets (5)	Sanitary Trench (6)	Landfill Area (7)	Cover Material (8)	Sewage Lagoons (9)	Septic Fields (10)	Play Grnd (11)	Picnic Area (12)	Camp Area (13)	Paths and Trails (14)	Permanent Bldg. Without Basements (4)
aR	Acidic Bedrock	Vb	Va	Vr	Vrt	Vrt	Vd	Pk	Vd	Vdt	Vd	Vrt	Vr	Vr	Vr	Vr
CAY	Cayer Series	Vw	Va	Vaw	Vaw	Vaw	Vsw	Vkw	Vsw	Vah	Vh	Vsw	Vsw	Vsw	Vsw	Vsw
FYL	Fyala Series	Ps	Va	Paw	Pw	Paw	Vw	Pw	Psw	G	Vh	Psw	Psw	Paw	Psw	Psw
KMK	Katimik Series	Pws	Va	Va	Vaw	Vws	Vwh	Vwh	Vsw	Vah	Vhg	Vsw	Vsw	Vsw	Vsw	Vaw
OOKX	Orok Complex	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg	Vsw	Vsw	Vsw	Vsw	Vaw
OVO	Overflowing Series	Vws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg	Vsw	Vsw	Vsw	Vsw	Vaw
STD	Stead Series	Vws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vha	Vsw	Vsw	Vsw	Vsw	Vaw
WHIX	Whithorn Complex	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg	Vsw	Vsw	Vsw	Vsw	Vaw
WKWX	Waskwei Complex	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg	Vsw	Vsw	Vsw	Vsw	Vaw

TABLE 7

Codes utilized to identify limitations in evaluating soil suitability for selected uses

a subgrade properties

b thickness of topsoil

c coarse fragments on surface

d depth to bedrock

e erosion or erodibility

f susceptibility to frost hazard

g contamination hazard of groundwater

h depth to seasonal water table

i flooding or inundation

j thickness of slowly permeable material

k permeability or hydraulic conductivity

l shrink-swell properties

m moisture limitations or deficit

n salinity or sulfate hazard

o organic matter

p stoniness

q depth to sand or gravel

r rockiness

s surface texture

t topographic slope class

u moist consistence

w wetness or soil drainage class

z permafrost

Guides for Assessing Soil Suitability

In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very poor", then the overall rating of the soil for that selected use is "Very poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

3.4 RECREATION

Recreational Development of the Soils

All kinds of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for camp sites, roads, play grounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The criteria used to evaluate soil suitability for recreational uses in many cases relate to engineering properties of soils and are adapted from guides found in Coen et al[9], and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[10] and the Canada Soil Survey Committee[11].

Soil Suitability for Selected Recreation Uses

The suitability of the various soil series and complexes for selected recreation uses is shown in Table 6, according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 7.

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[9] Coen et al, 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[10] USDA, 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service USDA. SCS-45. 87pp.

[11] CSSC, 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357pp.

Guides for Assessing Soil Suitability for Recreation Use

The guidelines for various recreation uses are presented in Appendix D, Tables 11 and Tables 18 to 21.

Appendix A

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7.0. See also Reaction, soil.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt. See Texture, soil.

Clayey - A soil particle size class used to describe soil materials with more than 35% clay by weight. See Particle size, soil.

Control section, soil - The vertical section upon which the taxonomic classification of soil is based. The control section usually extends to a depth of 100 cm in mineral materials and 160 cm in organic materials.

Decile portion - A one-tenth portion. As used in the soil map symbol A7 B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6 cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time when the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water

sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water storage capacity, Texture, and depth, and are either Gleysolic or Organic.

Ericaceous - Shrubby perennial plants of the Ericaceae (Heath) family. Includes such plants as leather leaf (Chamaedaphne calyculata), bearberry (Arctostaphylos uva-ursi), wild rosemary (Andromeda glaucophylla), sheep-laurel (Kalmia polifolia), and Labrador tea (Ledum spp.).

Exchange capacity - See cation exchange capacity.

Family, soil - A category in the Canadian system of soil classification. A soil family is a subdivision of a subgroup, carrying the additional differentiating properties of parent material characteristics, soil climatic factors, and soil reaction.

Forest - A plant association predominantly of trees and other woody vegetation.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Great group, soil - A category in the Canadian system of soil classification. These are subdivisions of each order, based on the strengths of the dominant processes in soil formation. Twenty eight soil great groups are currently recognized.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes. See Appendix B.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep

irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinguish one part of the earth's surface from another part.

Loam - A soil textural class. See also Texture, soil.

Loamy - A soil particle size class containing more than 15% fine sand or coarser particles by weight and less than 35% clay. See also Particle size, soil.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mineral soil - A soil consisting predominantly of, and having its properties determined predominantly by, mineral matter. It contains less than 17% organic carbon (30% organic matter) by weight, except for a mesic or humic organic layer up to 40 cm thick or predominantly fibric organic material up to 60 cm thick.

Moisture Regime - Annual moisture status of the unconsolidated soil material, expressing the moisture available to trees in descriptive terms. The broad classes used by foresters are given below with the approximate equivalent terms used by soil surveyors.

Dry	periodic to prolonged lack of soil moisture (excessively drained).
Fresh	adequate soil moisture supply, without prolonged lack or excess of soil moisture (well drained).
Moist	periodic excess of soil moisture (imperfectly drained).
Wet	prolonged to permanent excess to soil moisture (poorly drained).
Saturated	permanent excess of soil moisture at the surface (very poorly drained).

Order, soil - The highest division or category in the Canadian system of soil classification. Soils are categorized at the order level based on properties that reflect the soil environment and its effects on the dominant soil-forming processes. All the soils of Canada have been divided into nine orders; Brunisolic, Chernozemic, Crysolic, Gleysolic, Luvisolic, Organic, Podzolic, and Solonetzic.

Parent material - The unaltered or essentially unaltered mineral or

organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2 mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Permeability - The ease with which water and air pass through the soil to all parts of the profile. It is described as rapid, moderate or slow.

pH - The intensity of acidity and alkalinity, expressed as the logarithm of the reciprocal of the H+ ion concentration. pH 7 is neutral, lower values indicate acidity and higher values alkalinity.

Phase, soil - A soil phase is a unit of soil outside the system of soil taxonomy. It is a functional unit and is used at any categorical level from Order to Series. It is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH < 4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	> 9.0

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Series, soil - A category in the Canadian system of soil classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, and are formed from a particular type of parent material.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Subgroup - A category in the Canadian system of soil classification. A subgroup is a subdivision of a great group, differentiated on the basis of the kind and arrangement of soil horizons.

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Water table - (groundwater surface; free water surface; groundwater elevation). Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

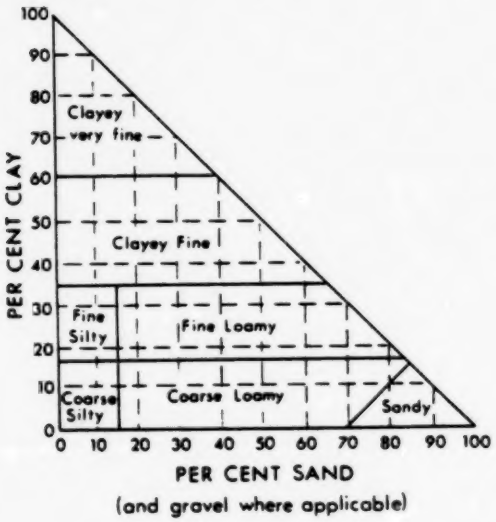
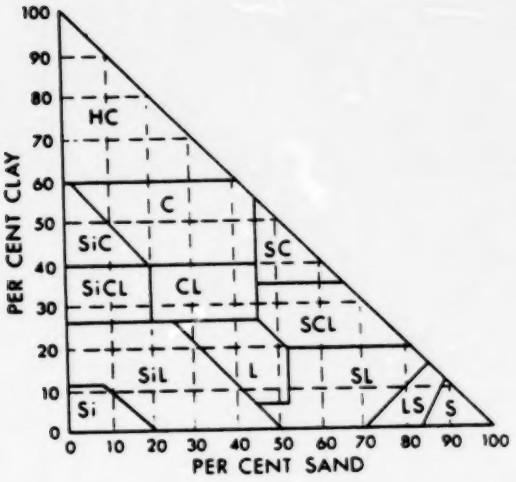


Figure 4: Family particle-size classes.



Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

Figure 5: Soil Textural Classes.

Appendix B

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic

matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

Appendix C

DESCRIPTION OF LANDFORMS

Organic Component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

Fiber Classes for Organic Materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic ma-

terial; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Organic Surface Classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the under-lying unit but still conforms to the general under-lying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 to 100 cm) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Appendix D

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

TABLE 8

Guide for assessing soil suitability as source of topsoil

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

4/ The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

5/ E.C. = Electrical Conductivity (millisiemens/cm).

TABLE 9

Guide for assessing soil suitability as source of sand and gravel

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2]	>75 cm[2]	
p	Stoniness[3]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

[1] The symbols are used to indicate the nature of the limitation.

[2] Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

[3] For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 10

Guide for assessing soil suitability as source of roadfill

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures <3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

3/ This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

4/ Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

5/ Downgrade suitability rating to fair if content of fines is more than about 30 percent.

6/ P.I. means plasticity index.

7/ Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

8/ Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

9/ For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 11

Guide for assessing soil suitability for permanent buildings

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
s	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

[1] By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

[2] The symbols are used to indicate the nature of the limitation.

[3] Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

[4] For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Reduce the slope limits by one half for those soils subject to hillside slippage.

[6] This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

[7] Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

[8] P.I. means plasticity index.

[9] Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

[10] Rate one class better for buildings without basements.

[11] Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

TABLE 12

Guide for assessing soil suitability for local roads and streets

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4]	>100 cm	50-100 cm	<50 cm	
a	Subgrade[5]				
	a. AASHO group index[6]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7] and SC[7]	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

1/ These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

2/ Symbols are used to indicate the nature of the limitation.

3/ For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

4/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

5/ This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

6/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

7/ Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

8/ P.I. means plasticity index.

9/ Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

TABLE 13

Guide for assessing soil suitability for trench-type sanitary landfills

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
s	Soil Texture[4],[6] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

1/ Based on soil depth (120 cm) commonly investigated in making soil surveys.

2/ The symbols are used to indicate the nature of the limitation.

3/ If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

4/ For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

6/ Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

7/ Soils high in expansive clays may need to be given a suitability rating of poor.

TABLE 14

Guide for assessing soil suitability for area-type sanitary landfills

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	>150 cm	100-150 cm	50-100 cm	<50 cm
c	Coarse fragments[2]	<15%	15-35%	>35%	
p	Stoniness[2]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
t	Slope	<9%	9-15%	15-30%	>30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

[4] Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

TABLE 15

Guide for assessing soil suitability as cover material for area-type sanitary landfills

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	>150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

TABLE 16

Guide for assessing soil suitability for reservoirs and sewage lagoons

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

1/ The symbols are used to indicate the nature of the limitation.

2/ If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

3/ Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

4/ For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

TABLE 17

Guide for assessing soil suitability for septic tank absorption fields

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

3/ Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

4/ Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

5/ A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

6/ Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

TABLE 18

Guide for assessing soil suitability for playgrounds

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2],[4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S,-Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

3/ Downgrade to a very poor suitability rating if the slope is greater than 5%.

4/ Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

TABLE 19

Guide for assessing soil suitability for picnic areas

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2,3]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2]	0-20%	20-50%	>50%	
p	Stoniness[2]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[2,5,6]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7]	Water storage capacity[8] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

3/ Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

4/ Moderately well and well drained SC, SiC and C soils may be rated fair.

5/ Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

6/ The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

TABLE 20

Guide for assessing soil suitability for camp areas

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2],[3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2],[5]	0-20%	20-50%	>50%	
p	Stoniness[2],[6]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2],[6]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

TABLE 21

Guide for assessing soil suitability for paths and trails

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4],[6]	0-20%	20-50%	>50%	
p	Stoniness[4]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	>60%
f	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

1/ The symbols are used to indicate the nature of the limitation.

2/ The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight affects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

3/ Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

4/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

7/ The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

8/ Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix E Morphological, Physical and Chemical Analysis

Horizon	Depth	Kind of Fiber	Color Wet Natural	Fiber Content Rubbed	Fiber Content Unrubbed	Texture	pH	Org. C %	TotN %	Exchange analysis Ca	Mg	Na	K	H	CEC me/100g	Pyrophos %	Ash
Whithorn Series																	
Of1	0-50	Sphagnum	7.5YR 5/6	98	99		3.0	57.7	4.4	6.1	4.6	.3	2.3	99.9	135.4	1.7	3
Of2	50-110	Sphagnum	7.5YR 4/4	78	88		3.5	59.7	6.5	10.2	26.1	.5	.4	82.0	128.8	7.5	7
Om1	110-160	Fen	7.5YR 3/2	44	76		4.6	63.2	14.9	25.0	23.2	.5	.1	63.0	113.3	5.1	7
Om2	160-250	For-fen	10YR 3/1	48	78		5.2	62.6	22.4	62.0	25.3	.6	.1	60.0	148.3	21.1	8
Oh1	250-265	For-fen	10YR 2/1	22	40		5.6	59.5	28.9	78.5	28.6	.8	.1	58.0	166.5	55.6	14
IICkg	265-273		5GY 5/1			CL	7.2			14.8	9.8	.4	.4		24.4		
Katimik Series																	
Of1	0-40	Sphagnum	7.5YR 7/6	82	84		3.5	56.8	11.5	13.3	7.2	.4	.8	99.9	123.3	11.7	12
Om1	40-170	For-fen	10YR 2/2	30	56		5.5	59.4	25.3	72.5	21.0	.3	.1	54.0	148.3	24.0	9
Om2	170-220	For-fen	5YR 2/2	18	44		5.6	62.0	27.8	68.6	25.3	.4	.1	51.0	146.5	31.4	11
IICg	220-230		5Y 5/1			C	7.0			20.6	12.1	.3	.3	2.0	34.5		
Waskwei Series																	
Of1	0-25	Sphagnum	2.5Y 7/4	82	99		3.8	57.4	8.0	19.9	11.4	.6	4.7	60.0	96.0	3.7	6
Of2	25-60	Forest	5YR 2.5/2	68	86		3.5	55.6	10.6	18.7	18.4	.6	.9	70.0	109.2	7.8	10
Om1	60-100	For-fen	5YR 2/2	30	56		5.0	61.9	24.8	58.6	25.2	.9	.1	63.0	147.4	13.1	9
Om2	100-180	Forest	5YR 2/1	14	60		5.4	61.3	25.2	77.3	30.6	.9	.1	65.0	173.4	32.2	9
Oh	180-190	For-fen	5YR 2/1	20	54		5.8	59.4	27.0	72.8	31.5	1.0	.1	57.0	166.1	50.0	15
IIAhg	190-205		5GY 4/1			H.C	6.9	2.3	2.0	22.5	18.6	.2	.9	8.0	47.0		
Stead Series																	
Of	0-40	Fen	10YR 3/2	78	99		6.2	55.5	20.3	47.1	23.2	.6	.2	33.0	103.3	11.7	12
Om1	40-160	Fen	10YR 2/2	26	48		5.8	62.9	28.1	72.0	25.4	.5	.2	47.0	145.2	21.2	7
Om2	160-200	Fen	10YR 2/2	18	42		6.2	52.3	26.5	77.7	30.5	.9	.1	37.0	144.7	46.2	22
IICg	200-210		5GY 5/1			SiL	7.6			28.4	8.8	.4	.3		17.3		

Appendix E

Water Chemistry of the Peatland in the Whitemouth Watershed
(check Figure 2 for site location in report)

Site No.	pH	Conductivity mS/cm	Ca ppm	Mg ppm	Na ppm	$CaCO_3$	Texture
4	6.8	0.1	18.0	7.3	2.3		
8	7.0	0.2	26.1	9.7	2.3		
12	6.7	0.1	16.0	7.3	2.3		
17	6.9	0.1	18.0	7.3	2.3		
18	6.8	0.2	30.0	10.9	2.3	24.4	SiC
19	7.0	0.1	16.0	7.3	2.3		
21	7.1	0.2	30.1	9.7	2.3		
22	6.9	0.2	22.0	9.7	2.3		
25	6.7	0.1	18.0	7.3	4.6		
27	6.7	0.1	4.0	6.0	0.0		
28	7.2	0.2	22.0	7.3	0.0		
29	7.1	0.2	26.0	8.5	4.6		
30	6.9	0.1	18.0	6.0	4.6		
31	6.4	0.2	22.0	6.1	0.0		
32	6.9	0.2	20.0	12.1	2.3		
33	4.4	0.1	2.0	3.6	0.0		
34	3.8	0.1	2.0	1.2	0.0		
35a	4.6	0.1	0.0	1.2	0.0		
35b	4.9	0.1	2.0	1.2	2.3		
36	4.7	0.1	4.0	3.6	0.0		
37	6.7	0.2	20.0	10.9	0.0		
38	6.8	0.2	20.0	10.9	6.9		
39	6.8	0.2	24.0	10.9	4.6	2.0	C
40	7.0	0.2	26.0	12.1	6.9		
41	7.1	0.2	26.0	13.4	2.3		
42	7.0	0.3	36.1	17.0	16.9		
43	6.8	0.2	16.0	10.9	2.3		
44	6.8	0.2	20.0	12.1	2.3		
45						9.1	C
46	6.8	0.2	24.0	10.9	0.0		
47	6.8	0.1	14.0	10.9	4.6		
49	6.9	0.3	36.1	15.8	2.3		
50	6.9	0.3	44.1	18.2	6.9		
51	7.1	0.3	32.1	17.0	9.2		
52	7.1	0.2	32.1	14.6	6.9		
53	7.1	0.2	24.0	12.2	2.3		
54	7.0	0.2	22.0	13.4	4.6		
55	6.7	0.1	14.0	7.3	2.3		
56	7.0	0.1	16.0	7.3	2.3		
57	4.5	0.1	4.0	2.43	4.6		
58	7.5	0.1	18.0	8.5	2.3		
59	7.6	0.1	26.0	7.3	2.3		
60	7.7	0.2	26.0	7.3	2.3		
61a	7.1	0.1	18.0	9.7	4.6		
61b	7.8	0.1	18.0	9.7	4.6		
65	7.7	0.2	26.0	7.3	4.6		
66	7.3	0.1	24.0	7.3	2.3		
67	7.4	0.1	28.1	7.3	2.3		
68	8.0	0.2	28.1	7.3	2.3		
69	8.0	0.2	38.1	8.5	2.3		
70	8.2	0.2	30.1	8.5	2.3		
73	7.2	0.2	34.1	8.5	2.3		
79	5.8	0.8	78.2	60.8	11.5		

Appendix F Soil Legend for Whitemouth Map

Map Symbol	Soil Name and Dominant Surface Texture	Profile Type	Landform and Topography	Soil Material	Natural Drainage	Dominant Vegetation
aR	Rock outcrop (acidic bedrock)		Irregular, gently sloping to hilly	Granitoid bedrock		
CAY	Cayer Series (mesic peat)	Terric Mesisol	Depressional to level horizontal and ribbed fen	40 to 160 of mesic fen peat with little or no (<15 cm) Sphagnum peat surface deposits. Underlain by strongly calcareous, loamy to clayey, stone free lacustrine sediments	Very poor to poor	Sedges and mosses with clumps of stunted black spruce and tamarack
FYL	Fyala Series (clay)	Rego Humic Gleysol	Depressional to level	Weakly to moderately calcareous lacustrine clay	Poor	Balsam poplar, aspen, sedges
KMK	Katimik Series (mesic peat)	Typic Mesisol, sphagnic phase	Depressional to level horizontal fen	Deep (>160 cm) mesic fen peat with a very thin (15-65 cm) fibric Sphagnum peat surface layer. Underlain by undifferentiated materials	Poor to very poor	Stunted black spruce and tamarack with an understory of dominantly Sphagnum moss and ericaceous shrubs
OOKX	Orok Complex (mesic peat)	Terric Mesisol, sphagnic phase* Terric Mesisol Terric Fibric Mesisol Terric Mesic Mesisol	Level to depressional flat and blanket bog	Shallow (40-160 cm) mesic forest peat with a very thin (<65 cm) fibric Sphagnum peat surface layer. Underlain by strongly calcareous loamy to clayey, stone free, lacustrine sediments	Poor to very poor	Black spruce, Sphagnum and ericaceous shrubs
OVO	Overflowing Series (mesic peat)	Typic Mesisol, aquic phase	Depressional to level, horizontal and ribbed fen	Deep (>160 cm) mesic fen peat with a hydric or semifluid layer occuring between 40-130 cms. Underlain by undifferentiated materials	Very poor	Sedges and mosses
STD	Stead Series (mesic peat)	Typic Mesisol	Depressional to level horizontal and ribbed fen	Deep (>160 cm) mesic fen peat or little or no (<15 cm) fibric Sphagnum peat overlying mesic fen peat. Underlain by undifferentiated materials	Very poor	Sedges and mosses
WHIX	Whithorn Complex (fibric peat)	Mesic Fibrisol* Typic Fibrisol Fibric Mesisol	Level to gently sloping domed bog	Deep (>160 cm) organic soils composed of fibric Sphagnum peat greater than 65 cm thick, overlying mesic forest or fen peat. Underlain by undifferentiated materials	Poor to very poor	Stunted black spruce with an understory of dominantly Sphagnum moss and ericaceous shrubs

WKWX	Waskwei Complex (mesic peat)	Typic Mesisol sphagnic phase* Typic Mesisol	Depressional to level flat and blanket bog	Deep (>160 cm) mesic forest peat with a very thin (<65 cm) surface layer of fibric Sphagnum peat overlying mesic forest peat	Poor to very poor	Black spruce with an understory of Sphagnum moss and ericaceous shrubs

* dominant series of complex

MAPS NOT

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